CORRECTION FOR COARSE PARTICLES IN THE SOIL COMPACTION TEST FOP FOR AASHTO T 224

Significance

01 The procedures used to determine moisture-density relations in soils and soil-aggregate mixtures (AASHTO T 99 or T 180) are performed on samples obtained by sieving material through specified sieves. AASHTO T 99 and T 180 use the 4.75 mm (No. 4) or 19.0 mm (3/4 in.) sieve depending on the method A, B, C, or D. These size limits are used because the equipment cannot accommodate large material.

When the material contains large particles, an adjustment must be made in the maximum dry density. Two methods are available for correction; lab to field or field to lab. This FOP will cover only lab to field corrections (see AASHTO T 224-00 for field to lab corrections).

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Scope

This procedure covers the adjustment of the maximum dry density determined by AASHTO T 99, or T 180 to compensate for coarse particles retained on the 4.75 mm (No. 4) or 19.0 mm (3/4 in.) sieve. For Methods A and B of AASHTO T 99 and T 180 the adjustment is based on the percent, by mass, of material retained on the 4.75 mm (No. 4) sieve and the bulk specific gravity (G_{sb}) of the material retained on the 4.75 mm (No. 4) sieve. A maximum of 40% of the material can be retained on the 4.75 mm (No. 4) sieve for this method to be used. For Methods C and D of AASHTO T 99 and AASHTO T 180, the adjustment is based on the percent, by mass, of material retained on the 19.0 mm (3/4 in.) sieve and the G_{sb} of the material retained on the 19.0 mm (3/4 in.) sieve. A maximum of 30% of the material can be retained on the 19.0 mm (3/4 in.) sieve for this method to be used. Whether the split is on the 4.75 mm (No. 4) or the 19.0 mm (3/4 in.) sieve all material retained on that sieve is defined as oversized material.

This method applies to soils with percentages up to the maximums listed above for oversize particles.

A correction may not be practical for soils with only a small percentage of oversize material. Agency shall specify a minimum percentage below which the method is not needed. If not specified, this method applies when more than 5 percent by weight of oversize particles is present.

Adjustment Equation for Moisture

Along with density the moisture content can be corrected. The moisture content can be determined by the FOP for AASHTO T 255 / T 265, FOP for
04 AASHTO T 217 or the Nuclear density gauge moisture content reading from the FOP for AASHTO T 310. If the nuclear gauge moisture reading is used or when the moisture content is determined on the entire sample (both fine and oversized particles) the use of the adjustment equation is not needed. Combined moisture contents with material having an appreciable amount of silt or clay should be performed using the FOP for AASHTO T 255 / T 265 (Soil). Moisture contents used from FOP for T 310 must meet the criteria for that method.

When samples are split for moisture content (oversized and fine materials) the following adjustment equations must be followed.

1. Split the sample into oversized material and fine material.
2. Dry the oversized material following the FOP for AASHTO T 255 / T 256 (Aggregate). If the fine material is sandy in nature dry using the FOP for AASHTO T 255 / T 256 (Aggregate), or FOP for AASHTO 217. If the
05 fine material has any appreciable amount of clay, dry using the FOP for AASHTO T 255 / T 265 (Soil) or FOP for AASHTO T 217.

3. Calculate the dry mass of the oversize and fine material as follows.

$$M_D = \frac{M_m}{(1+MC)}$$

06 Where:

M_D = mass of dry material (fine or oversize particles).

M_m = mass of moist material (fine or oversize particles).

MC = moisture content of respective fine or oversized, expressed as a decimal.

4. Calculate the percentage of the fine and oversized particles by dry weight of the total sample as follows: See note 2.

$$P_f = \frac{100\,M_{DF}}{(M_{DF}+M_{DC})} \qquad 73.0\% = \frac{(100)\ \ (15.4\text{lbs})}{(15.4\ \ +\ 5.7\,lbs\ )}$$

$$73.0\% = \frac{(100)\ \ (7.034\text{kg})}{(7.034\ \ +\ 2.602\ )}$$

And

$$P_c = \frac{100\,M_{DC}}{(M_{DF}+M_{DC})} \qquad 27.0\% = \frac{(100)\,(5.7\text{lbs})}{(15.4+5.7lbs)}$$

$$27.0\% = \frac{(100)\ \ (2.602\text{kg})}{(7.034\ +\ 2.602\,kg\,)}$$

Where:

P_f = percent of fine particles, of sieve used, by weight.

P_C = percent of oversize particles, of sieve used, by weight.

M_{DF} = mass of fine particles.

M_{DC} = mass of oversize particles.

5. Calculate the corrected moisture content as follows:

$$MC_T = \frac{[(MC_F)(P_f) + (MC_c)(P_c)]}{100}$$

MC_T = corrected moisture content of combined fines and oversized particles, expressed as a % moisture.

MC_F = moisture content of fine particles, expressed as a % moisture.

MC_C = moisture content of oversized particles, expressed as a % moisture.

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$$MC_T = \frac{[(10.6)(73) + (2.1)(27)]}{100}$$

Note 1: Moisture content of oversize material can be assumed to be two (2) percent for most construction applications.

Note 2: In some field applications agencies will allow the percentages of oversize and fine materials to be determined with the materials in the wet state.

Adjustment Equation Density

6. Calculate the corrected dry density of the total sample (combined fine and oversized particles) as follows:

$$D_d = \frac{100\,D_f\,k}{[(D_f)(P_c) + (k)(P_f)]}$$

or

$$D_d = \frac{100}{\frac{P_f}{D_f} + \frac{P_c}{k}}$$

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Where:

D_d = corrected total dry density (combined fine and oversized particles) kg/m^3 (lb/ft^3).

D_f = dry density of the fine particles determined in the lab kg/m^3 (lb/ft^3)

P_C = percent of oversize particles, of sieve used, by weight

P_f = percent of fine particles, of sieve used, by weight

k = Metric:

1,000 * G_{sb} (oven dry basis) of coarse particles (kg/m^3).

Or

English:

62.4 * G_{sb} (oven dry basis) of coarse particles (lb/ft^3).

Note 3: If the G_{sb} is known, then this value will be used in the calculation. For most construction activities the G_{sb} of aggregate may be assumed to be 2.600.

Calculation

Sample Calculations:

- Metric:

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Maximum laboratory dry density (D_f):	2329 kg/m^3
Percent coarse particles (P_C):	27%
Percent fine particles (P_f):	73%
G_{sb} of coarse particles (k):	(2.697) (1000) = 2697 kg/m^3

$$D_d = \frac{(100)\,(2329\text{kg/m}^3)(2697\text{kg/m}^3)}{[(2329\text{kg/m}^3)\,(27) + (2697 kg/m^3)(73)]}$$

$$D_d = \frac{628{,}131{,}300.0}{[62{,}883.0 + 196{,}881]}$$

$$D_d = \frac{628{,}131{,}300.0}{259{,}764.0}$$

- D_d = 2418.1 say 2418 kg/m^3

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- English:

Maximum laboratory dry density (D_F):	140.4 lb/ft^3
Percent coarse particles (P_C):	27%
Percent fine particles (Pf):	73%
G_{sb} of coarse particles (k):	(2.697) (62.4) = 168.3 lb/ft^3

$$D_d = \frac{(100)\,(140.4\,\text{lb/ft}^3)(168.3\,\text{lb/ft}^3)}{[(140.4\,\text{lb/ft}^3)\,(27) + (168.3\,lb/\,ft^3)(73)]}$$

$$D_d = \frac{2{,}362{,}932.0}{[3790.8 + 12285.9]}$$

$$D_d = \frac{2{,}362{,}932.0}{16{,}076.7}$$

$D_d = 146.98$ say 147.0 lb/ft^3

Tips!

- Base the adjustment on the percent retained the sieve size specified in the FOP for AASHTO T 99 / T 180.

Report

Results shall be reported on standard forms approved by the agency. Report adjusted maximum dry density to the closest 1 kg/m^3 (0.1 lb/ft^3).

REVIEW QUESTIONS

1. Describe the purpose of this procedure.

2. The adjustment is based on the mass of material retained on what size sieve?

3. A soil-aggregate mixture has a maximum dry density of 2351 kg/m^3metric units or 138.6 lb/ft^3 English units. The coarse particles make up 22 percent of the material, and have a G_{sb} of 2.631.

   What is the corrected maximum density?